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(54) Title: FIBER-FORMING POLYMER BLEND AND PIGMENTED FIBERS FORMED THEREFROM

(57) Abstract

A fiber-forming polymer blend is disclosed. The blend is particularly useful in forming fibers, including pigmented fibers, which resist staining by acid dyes.

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FIBER-FORMING POLYMER BLEND AND PIGMENTED FIBERS FORMED THEREFROM

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention is directed to a polymer blend and to synthetic fibers formed therefrom. More particularly, the present invention is directed to a polymer blend useful in forming pigmented synthetic fibers which resist staining by acid dyes and the like.

Description of the Prior Art

Polyamides such as nylon 6 and nylon 6,6 are known in the art to be useful as pile yarn for carpet and further to have an affinity for acid dyes. While this characteristic imparts a desirable level of acid dyeability to fibers formed from polyamides, it also imparts to these same fibers a susceptibility to undesirable staining by conventional food colorants and other materials which contain acid dyes.

Prior art techniques for resisting this tendency to stain in dyed nylon fibers include topically applying to the fiber a material which functions as a stainblocker or stain resist agent. This technique is exemplified in U.S. Reissue Patent No. 33,365 to Ucci. While highly effective in imparting resistance to acid dye stainants, the use of topically applied stainblockers can add significant processing and materials cost to the fiber product. Further, the topically applied stainblocker could be removed from the fiber over time by abrasion or aggressive cleaning with harsh chemicals. This may be especially problematic in the commercial carpet field, where flooring systems are subjected to extreme wear conditions and are often cleaned with harsh chemicals such as bleach.

A technique for producing pigmented fibers which resist staining by acid dyes is disclosed in U.S. Patent No. 5,108,684. In this process, a sulfonated

nylon copolymer is first formed via addition of a cationic dyeability additive, pigment is then added to the copolymer and the polymer/pigment blend is spun to produce a pigmented, stain resistant fiber. This process also has drawbacks. For example, it is noted in the subject patent that the performance of the nylon with some pigments may be made slightly worse by the additive. Further, the need for introduction of an additive in the polymerization stage can increase manufacturing and materials cost.

A need therefore exists for a fiber, for example, a pigmented fiber, which exhibits permanent stain resist properties which can be economically and effectively imparted to the fiber.

BRIEF SUMMARY OF THE INVENTION

The present invention satisfies this need and achieves other advantages set forth in more detail below by providing a fiber including a fiber-forming polymeric matrix which includes a blend of a nylon polymer and a sulfonated non-nylon polymer. The fiber may also include at least one pigment dispersed in the matrix.

The fiber of the present invention is particularly useful in making pile yarn for carpet which resists staining by acid dyes and the like.

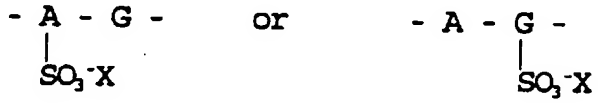
DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The term "fiber", as used herein, is defined to include continuous filaments as well as staple fibers formed therefrom.

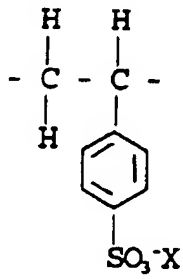
The fiber of the present invention includes a fiber-forming polymeric matrix which includes a nylon polymer. The term "nylon polymer", as utilized herein, is defined to include all polyamide polymers having recurring amide units as an integral part of the polymer chain. The term "polymer", as utilized herein, is

meant to include homopolymers, copolymers, terpolymers and the like, as well as mixtures or blends of two or more polymers. Non-limiting examples of suitable nylon polymers include nylon 6,6, nylon 6, nylon 6,6/6 copolymers and the like. The preferred nylon polymer is nylon 6,6.

The fiber-forming matrix further includes a sulfonated non-nylon copolymer. The sulfonated non-nylon polymer utilized in the subject polymeric fiber-forming matrix can be any polymer which (1) includes sulfonate groups, defined as SO_3^- or SO_3^-X wherein X is a monovalent cation, for example K^+, Na^+, Li^+, NH_4^+ and the like, pendant from the polymer chain and (2) is substantially free from amide linking groups in the polymer chain. Non-limiting examples include sulfonated polyester polymers including repeat units of the formula:



wherein A is a diacid moiety, G is a glycol or polyglycol moiety, and X is defined as above; and sulfonated polystyrene polymers, including repeat units of the formula:



wherein X is a monovalent cation.

A preferred sulfonated non-nylon polymer utilized in the subject polymeric matrix has a sulfur content of from about 1.5% by weight to about 6.0% by weight sulfur, most preferably about 2.0% to about 4.0%

by weight sulfur based on the total weight of the sulfonated non-nylon polymer.

A particularly preferred sulfonated non-nylon polymer is a sulfonated polyester polymer having a sulfur content of from about 1.5% by weight to 6.0% by weight sulfur, most preferably about 2.0% to about 4.0% by weight sulfur, based on the total weight of the sulfonated polyester polymer and including repeat units of the formula:

wherein A is an aromatic dicarboxylic acid moiety and G is an aliphatic or cycloaliphatic glycol moiety.

A suitable sulfonated polyester polymer has about 2.1% by weight sulfur based on the total weight of the polyester polymer and is commercially available from Eastman Chemicals, Kingsport, Tennessee, under the trade name AQ 55S.

The nylon and sulfonated non-nylon polymer described above are included in the fiber-forming polymer matrix of the present invention. It has unexpectedly been discovered that the fiber of the present invention resists staining by acid dyes. While not wishing to be bound by any theory, it is believed that this result is at least partially due to the good miscibility of the two polymers utilized in the fiber-forming matrix when blended in melt form. The nylon polymer and the sulfonated non-nylon polymer are miscible with each other such that substantially no phase separation can be detected between the nylon polymer and the sulfonated polymer in the fiber-forming matrix. Applicant has termed the matrix as a "blend", however, to connote that, while the two polymers are miscible, they do not copolymerize to any significant extent.

The relative amounts of nylon polymer and sulfonated non-nylon polymer will vary depending on numerous factors including, for example, the sulfur content of the sulfonated non-nylon polymer and the amine end group concentration in the fiber-forming matrix. Preferably, the sulfonated non-nylon polymer is present in the fiber-forming matrix in an amount of about 2% to about 10% by weight based on the total weight of the polymeric fiber-forming matrix. Most preferably, the sulfonated non-nylon polymer is present in an amount of about 3% to about 7% by weight based on the total weight of the polymeric fiber-forming matrix.

The fiber of the present invention is preferably a pigmented synthetic fiber which further includes at least one pigment dispersed in the fiber-forming polymer matrix. Typically, the fiber includes from about 0.1% to about 5.0% pigment based on the total weight of the fiber. Suitable pigments are well known in the art and include, for example, inorganic pigments such as titanium dioxide, iron oxide and the like, as well as organic pigments such as carbazole blue, perylene red and the like. Combinations of two or more pigments are also contemplated by the present invention as a means to provide a widely varied color selection palette for the fibers of the present invention. For example, titanium dioxide may be combined with at least one pigment other than titanium dioxide to produce lighter color shades.

The fiber of the present invention optionally also includes effective amounts of additives which are useful in improving the manufacturing processability and/or end-use performance of the fibers. Non-limiting examples of these additives include ionic copper, typically in the form of copper compounds such as copper acetate, copper halides, antioxidants such as TINUVIN® available from Ciba Geigy, UV stabilizers such as manganese hypophosphite, antimicrobials such as zinc ox-

ide, electroconductive materials such as carbon black and the like. Moreover, the fibers of the present invention may also include topically applied materials, for example, fluorochemicals, stainblockers and the like.

The fiber of the present invention is particularly useful in the manufacture of pile yarn for carpets and therefore preferably include a number of features or characteristics desirable for this utility. The fiber of the present invention preferably is a monocomponent fiber having a cross-section common to conventional carpet fiber manufacture including, for example, round, multilobal, hollow and the like. Further, the fiber preferably has a smooth, non-porous surface to provide desirable light reflectance characteristics. The denier of the fibers of the present invention is preferably about 6 denier per filament (dpf) to about 25 dpf. A pile yarn including a plurality of fibers of the present invention preferably will have a denier of at least about 500.

In a preferred embodiment, the pigmented fiber of the present invention is made, generally, by providing a nylon polymer and a sulfonated non-nylon polymer, forming the fiber-forming polymeric matrix from the polymers, blending at least one pigment, along with any optional additives, with the fiber-forming polymer matrix and spinning the pigment/polymer matrix blend into a fiber.

The polymeric matrix is preferably formed by melting the polymeric components of the matrix and combining the components in their melt form. A heated screw extruder or similar device is useful in forming the polymeric matrix as the components of the matrix can be fed to the extruder in flake form and subsequently combined therein while the polymers are in the molten state.

The polymeric matrix is blended with the pigment to form a pigment/polymer matrix blend wherein preferably the pigment is substantially evenly dispersed in the matrix. The pigment may be added in this blending step in pure form or, more preferably, in the form of a conventional "color concentrate" which includes one or more pigments dispersed in a host polymer. Most preferably, the host polymer is compatible with the fiber-forming polymeric matrix and is chosen from the group consisting of nylon 6, nylon 6,6 and copolymers and blends thereof.

In a first preferred embodiment, the matrix-forming step and the blending step are sequential such that the process includes the steps of providing a nylon polymer and a sulfonated non-nylon polymer; blending said polymers at least partially under conditions sufficient to reduce said polymers to a molten state to form a fiber-forming matrix; and then blending said matrix while in a molten state with at least one pigment to form a pigment/fiber-forming matrix blend. Typically the blending steps are performed by a mixing device such as a heated screw extruder. Preferably, the pigment is introduced in the form of a concentrate.

In a second preferred embodiment, the matrix forming step and the blending step are simultaneous such that the process includes providing a nylon polymer, a sulfonated non-nylon polymer and at least one pigment; and blending said nylon polymer, said sulfonated non-nylon polymer and at least one pigment at least partially under conditions sufficient to reduce the polymers to a molten state to form a pigment/fiber-forming matrix blend. Typically, the blending step is performed in a mixing device such as a heated screw extruder. In this embodiment, the pigment may be introduced in the form of a color concentrate or, optionally, it is dispersed in one or both of the polymeric

components of the fiber-forming matrix prior to forming the matrix/pigment blend.

Once the matrix/pigment blend is formed, the next step in the process includes spinning the blend into fiber. In the spinning step, the pigment/molten fiber-forming matrix blend is extruded through the capillaries of a conventional spinneret to form a plurality of molten streams which cool and solidify to form fiber. Spinning devices and systems therefore are conventional and well known in the art.

As the fibers of the present invention are preferably utilized in the manufacture of carpet pile yarn, the process of the present invention preferably includes further processing for this utility. Additional processing steps may include, for example, drawing the fiber by conventional means to impart increased molecular orientation thereby increasing fiber strength; crimping and/or texturing the fiber by conventional means, e.g. an air jet or stuffer box; and forming a staple or bulked continuous filament (BCF) yarn utilizing conventional staple or BCF processing techniques. Carpet may be then prepared by tufting the yarn into a backing material, typically a woven or non-woven fabric, to form the carpet pile and applying (1) an adhesive to the underside of the backing to further unite the yarn with the backing and (2) a secondary backing to the adhesive.

Although the fibers of the present invention have been described in detail above, it should be understood that various modifications may be made thereto without departing from the spirit and scope of the invention. For example, the fibers of the present invention may further include additives and/or coatings which may enhance the performance of the fiber in a specific utility or improve the processability thereof, including, for example, fluorochemicals, stainblockers, finishes and the like. Further, the fibers of the

present invention may be combined with other fibers, for example, electrically conductive fibers or unpigmented fibers, to form fiber blends. In addition, fibers of the present invention having a specific pigment system may be combined with other pigmented fibers, including those of the present invention having a different pigment system, to produce a multicolor fiber blend.

I CLAIM:

1. A pigmented synthetic fiber comprising
   (a) a polymeric fiber-forming matrix including a nylon and a sulfonated non-nylon polymer; and
   (b) at least one pigment dispersed in said matrix.

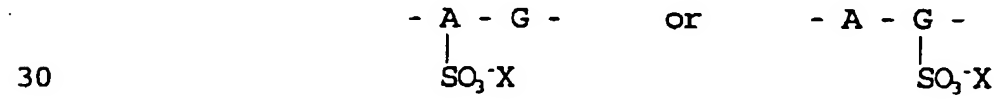
2. The fiber of claim 1 wherein said sulfonated non-nylon polymer has a sulfur content of from about 1.5% by weight to about 6% by weight sulfur based on the total weight of said sulfonated non-nylon polymer.

3. The fiber of claim 2 wherein said sulfonated non-nylon polymer is present in an amount of about 2% to about 10% by weight based on the weight of said matrix.

4. The fiber of claim 1 wherein said sulfonated non-nylon polymer has a sulfur content of about 2.0% to about 4.0% by weight sulfur based on the weight of said sulfonated non-nylon polymer.

5. The fiber of claim 4 wherein said non-nylon polymer is present in an amount of about 3% to about 7% by weight based on the total weight of said matrix.

6. A pigmented synthetic fiber comprising
   (a) a polymeric fiber-forming matrix including a nylon and a sulfonated polyester polymer including repeat units of the formula:



   wherein A is a diacid moiety, G is a glycol or polyglycol moiety, and X is a monovalent cation; and
   (b) at least one pigment dispersed in said matrix.

7. The fiber of claim 6 wherein said sulfonated polyester polymer has a sulfur content of from about 1.5% by weight to about 6% by weight sulfur based on the total weight of said sulfonated polyester polymer.

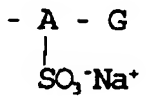
8. The fiber of claim 7 wherein said sulfonated polyester is present in an amount of about 2% to about 10% by weight based on the weight of said matrix.

9. The fiber of claim 6 wherein said sulfonated polyester has a sulfur content of about 2.0% to about 4.0% by weight based on the weight of said sulfonated polyester.

10. The fiber of claim 9 wherein said sulfonated polyester is present in an amount of about 3% to about 7% by weight based on the total weight of said polymeric matrix.

11. A pigmented synthetic fiber comprising

(a) a polymeric fiber-forming matrix including a nylon and from about 2% to about 10% by weight based on the weight of said matrix of a sulfonated polyester polymer having repeat units of the formula:



wherein A is an aromatic dicarboxylic acid moiety and G is an aliphatic or cycloaliphatic glycol moiety and wherein said sulfonated polyester polymer has a sulfur content of from about 1.5% by weight to about 6% by weight sulfur based on the total weight of said sulfonated polyester, and

(b) at least one pigment dispersed in said matrix.

INTERNATIONAL SEARCH REPORT

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PCT/US 95/15045

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 D01F6/90 D01F1/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 D01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DATABASE WPI Section Ch, Week 9029 Derwent Publications Ltd., London, GB; Class A23, AN 90-219445 & JP,A,02 145 808 (TEIJIN KK) , 5 June 1990 see abstract ---	1-11
A	DATABASE WPI Section Ch, Week 9327 Derwent Publications Ltd., London, GB; Class A28, AN 93-217059 & JP,A,05 140 499 (TEIJIN LTD) , 8 June 1993 see abstract -----	

☐ Further documents are listed in the continuation of box C.

☐ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
4 April 1996	17 -04- 1996

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